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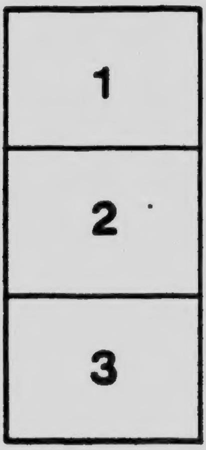

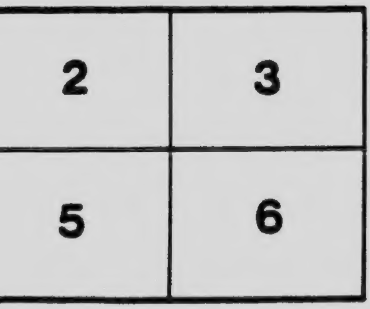

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# UNIVERSITY OF TORONTO STUDIES

## PAPERS FROM THE PHYSICAL LABORATORIES

## No. 62: THE ABSORPTION OF HELIUM BY CHARCOAL,

BY STUART McLEAN

(REPRINTED FROM TRANSACTIONS OF THE ROYAL SOCIETY OF CANADA, SERIES III, VOL. XII)

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# *The Adsorption of Helium by Charcoal.*

By STUART McLEAN, M.A.
University of Toronto

Presented by PROFESSOR E. F. BURTON, Ph.D., F.R.S.C.

(Read May Meeting, 1918.)

Sir James Dewar[1], investigating the efficiency of the use of charcoal in the production of high vacua, made an experiment with helium when the charcoal was cooled to the temperature of liquid hydrogen. He found that at a temperature of 20° absolute, charcoal is a good adsorbent of helium. By boiling the liquid hydrogen under exhaustion, he was able to obtain a temperature of 15° absolute. At this temperature, charcoal is a much better adsorbent of helium.

As the adsorption of helium at liquid air temperature is very small, it was impossible to investigate its adsorption as fully as for other gases. The following are the results of a series of experiments by Miss Homfray:[2]

| P. | T. | V. | V. not adsorbed. | V. adsorbed. |
|---|---|---|---|---|
| 48·4 | 17°C | 4·64cc. | 4·64 cc. | 0·00 cc. |
| 32·7 | − 78 | 4·64 | 4·50 | 0·14 |
| 12·0 | −190 | 4·64 | 3·64 | 1·00 |
| 70·4 | 14 | 6·71 | 6·71 | 0·00 |
| 17·1 | −190 | 6·71 | 5·33 | 1·38 |
| 67·4 | − 78 | 9·72 | 9·25 | 0·47 |
| 50·3 | −128 | 9·72 | 9·22 | 0·50 |
| 23·5 | −190 | 9·72 | 7·32 | 2·40 |
| 42·75 | −190 | 17·80 | 14·34 | 3·46 |
| 70·50 | −190 | 27·45 | 21·00 | 6·45 |

The amount of gas worked with is usually so small that measurements of volumes by observation of pressures in a comparatively large apparatus give very discordant results. The object of this research was to investigate the absolute amount of helium absorbed by a given amount of charcoal and how the amount absorbed depended on the quantity of helium put into the apparatus. Different quantities of helium were admitted into the apparatus, left for half an hour, and then all the gas not absorbed was pumped out; that is the equilibrium pressure was practically zero.

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[1] Dewar: *Proc. Roy. Soc. Lon.*, 74, 1904, p. 122. *Chem. News*, 90, 1904, p. 145.
[2] Homfray: *Zs. f. phys. Chem.*, 74, 1910, p. 129.

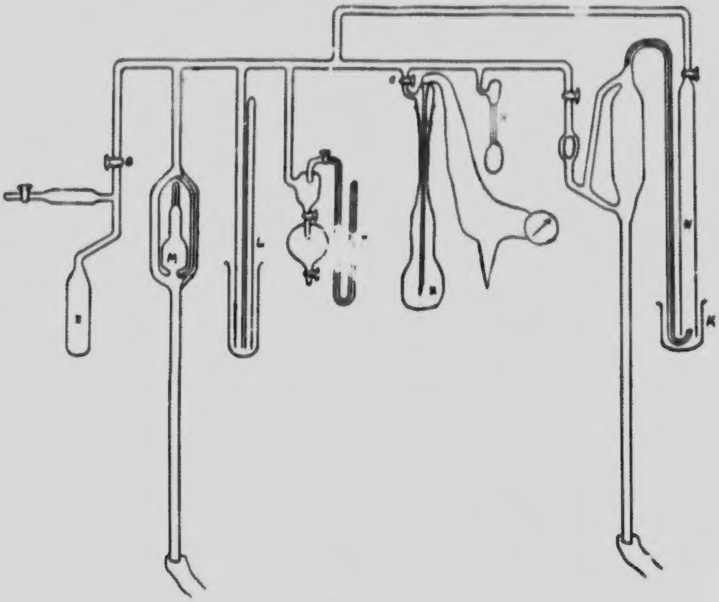

Figure 1

A diagram of the apparatus is shown in Fig. I. The charcoal (30 grams) is contained in the tube X, which may be shut off from the rest of the apparatus by means of the stop-cock C. Before each experiment, this tube was heated in an electrical resistance furnace to a temperature of 440° C and, while it was hot, the apparatus was exhausted. The charcoal tube Z was immersed in liquid air and used to complete the exhaustion. It could be shut off from the rest of the apparatus at B. The discharge tube H was used to test the vacuum.

A measured amount of gas was introduced at the Traver's siphon T or through the tube N. Its pressure was read on the McLeod gauge M or the barometer tube L. The stop-cock C was then opened and the gas allowed to remain in contact with the cold charcoal for at least thirty minutes. The unadsorbed gas was then pumped out and collected in tubes over mercury at K. The difference between the amount of gas introduced to the apparatus and that pumped out, was considered to be the amount adsorbed by the charcoal.

The following table gives the results of a series of experiments.

| No. | Temperature | Volume | Volume not adsorbed | Volume adsorbed |
|---|---|---|---|---|
| 1. | Liquid Air | 8·50 cc. | 8·36 cc. | 0·14 cc. |
| 2. | — | 18·42 | 18·32 | 0·10 |
| 3. | — | 18·52 | 18·37 | 0·15 |
| 4. | — | 29·58 | 29·44 | 0·14 |
| 5. | — | 34·97 | 34·73 | 0·24 |
| 6. | — | 41·69 | 41·40 | 0·29 |
| 7. | — | 41·98 | 41·87 | 0·11 |

These results go to show that a very small quantity of helium is adsorbed by charcoal at the temperature of liquid air.

This work was carried out under the direction of Professor E. F. Burton.

# UNIVERSITY OF TORONTO STUDIES

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